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On behalf of spore gods.

ALASDAIR RICHMOND

This paper argues that applying ideas from (especially) general relativity can support interesting theses about death and its harm advanced by Roy Sorensen. In particular, if we look at our own personal time through the lens of certain relativistic spacetimes, we find coherent models for some apparently very counter-intuitive lives, but lives whose possibility can nonetheless shed light on whence death gets its harm and that could, for all we currently know, be actual.

Sorensen (2005) tackles death's harm via Lewis (1976: 145) on time travel (TT):

Inevitably, [TT] involves discrepancy between time and time. Any traveler departs and then arrives at his destination; the time elapsed from departure to arrival (positive, or perhaps zero) is the duration of the journey. But if he is a time traveler, the separation in time between departure and arrival does not equal the duration of the journey.

TT discrepancies divide *external time* (Xt) from *personal time* (Pt): no TT if $Pt = Xt$; TT iff $Pt \neq Xt$. Xt tracks some suitably-inclusive reference frame outwith the traveller; Pt tracks *everything* co-moving with the traveller, (e.g. watch, memory, digestion, etc.). (Cf. relativistic τ or 'proper time': time *proper* to a worldline.) Pt need not be 'personal' *qua* consciousness; countries, continents or planets have historical, geological or tectonic Pt . Traveller identity tracks Pt and $Pt \geq 0$. Adapting Lewis, Pt and Xt share duration *and direction* in non-TT persistence, hence:

Forward TT (FTT): $(Pt \neq Xt) \& (Xt > 0)$;
Backward TT (BTT): $(Pt \neq Xt) \& (Xt \leq 0)$.¹

Note: i) the claim is *not* that Xt or Pt alone suffice to define TT.

ii) A journey is BTT if Xt is *ever* negative, i.e. not just if overall Xt is negative.²

¹Note *directional* BTT inequality: you still TT if you take 'one hour [Pt] to travel one hour [Xt] into the past', (Bernstein 2015: 160). The durations have the same *magnitude* but still $(Pt \neq Xt)$: e.g. $|1| = |-1|$ yet $1 \neq -1$. Daniels (2014: 316) usefully treats such cases as involving *ordering* discrepancies.

² Lewis (1976) covers FTT and BTT, while Malament (1984: 91) covers BTT alone: "I take 'time travel' to be nothing more, and nothing less, than the act of starting at a particular point in spacetime, taking an otherwise conventional trip, and somehow returning to (or close to) that very point".

However, Lewis makes some resistible claims. First, Lewis (1976: 146) parenthetically suggests BTT includes ($Pt > Xt > 0$) cases. This seems unconvincing: such Pt runs fast compared to Xt but stays future-directed nonetheless. Secondly, Lewis (*ibid.*) says Xt is ‘time itself’ while Pt ‘isn’t really time, but it plays the role in [a traveller’s] life that time plays in the life of a common person’. Xt is ‘genuine time’ to Nowacki (2006: 84). Sorensen (2005: 122) says Pt is ‘a time-like relation that can govern vast portions of the universe’. Such glosses can mislead. Far better, Bernstein (2015: 160) glosses Xt as ‘time on the “normal” forward-evolving timeline’. Relativity knows no absolute ‘time itself’ but allows TT: duration differs between reference-frames but no frame is ontologically privileged. Pt too is ‘genuine time’. Cf Horwich (1975: 433) on a (500-year Xt : 15-minute τ) relativistic time-journey:

Giving up the notion of absolute time and relativizing time to frames of reference allows us to view the 500 years of earth-time and the 15 minutes of the proper-time of the time machine as equally good and correct measures of the temporal difference between the year 2500 and the departure of the time machine.

Pt and Xt have frame-relative durations but are not thereby subjective, illusory or derivative. *Pace* Lewis, non-absolute (relativistic) time allows TT: ‘The temporal interval that is traversed and the duration of the journey are measured in different frames of reference’, (Horwich 1975: 433). While τ -values are absolute, considerations like mass-energy distribution make some τ -values more salient as Xt or Pt . Taking as Xt the τ of a cosmic ray approaching Earth at $0.999 c$ is a possible but impractical choice. For astronauts passing (e.g.) the galaxy Andromeda, time proper to Andromeda’s mean centre of motion is plausibly Xt . As Andromeda moves relative to its local galactic cluster,³ the astronauts’ Xt is a still bigger frame’s Pt . Unlike duration, τ and causal order are invariants. (Causal *structure* and τ remain

³Which is also ours: the Local Group, itself part of the Virgo Supercluster.

absolute even in BTT.) Adapting Lewis (1976) to relativity means ‘whether or not something is a time traveller should vary from frame to frame’, (Daniels 2014: 338).

Sorensen claims death harms by curtailing Pt and deathlike harm can occur sans death. To support these claims, he offers (2005: 123) ‘spore gods’, (past-and-future $Pt < \infty$; past-and-future $Xt = \infty$):

One schedule is suggested by a temporal interpretation of the following sequence: ... $-1/16$, $-1/8$, $-1/4$, 0 , $1/4$, $1/8$, $1/16$, ... At the present moment, you are at the midpoint of your life. From this zero point, there is a Zeno sequence that goes forward much as before. The difference is that the quantity to be divided is the remaining half of your life. The other half has already been divided backwards: the first previous quarter of your life is preceded by the previous eighth, that eighth by a sixteenth, and so on. Since each part has intermissions, you have already lived infinitely many years. There is no time before all the moments of your life. You have no beginning. You have no end.⁴

Nowacki (2006: 84) thinks such examples modally confused: ‘Sorensen does not tell us which sort of modality he has in mind ... but one can bank on its being broader than physical possibility’. Compare ‘*The Staccato Life*’ of Moore (2006: 315):

I live normally for forty years, and these are followed by a trillion years of unconsciousness at the end of which everything reverts to the state that it was in at the beginning of that trillion-year period. I then live normally for twenty years, and these are followed [by] a similarly undetectable trillion-year period of unconsciousness. I then live normally for ten years, and these in turn are followed by the same thing. And so on *ad infinitum*.

Nowacki (2006: 84) rightly objects that no organism on remotely human physical lines could survive ever-briefer state-transitions or register ever-briefer experiences. For any integer n , any ‘Eleatic’ spore god has arbitrarily-many past and future Pt increments shorter than $1/n$ seconds but all supposedly summing to a unified life. (If the increments don’t unify, then there is no Pt -continuity and no spore god.) However, Nowacki (2006: 91) also queries Sorensen immortals on un compelling

⁴Named for Nagel (1979: 8 fn. 3): ‘We could imagine discovering that people developed from individual spores that had existed indefinitely far in advance of their birth’, which example Nagel credits (*ibid.*) to Robert Nozick. Sorensen’s ‘veiled immortals’ (future $Xt = \infty$, future $Pt < \infty$) and ‘pseudo-immortals’ (future $Pt = \infty$, future $Xt < \infty$) will be covered elsewhere.

metaphysical grounds, e.g. that infinite Pt accessible in finite Xt would allow impossible actually-infinite objects, such as circles of infinite radius:

It is metaphysically impossible for there to exist an actually infinite circle. ... By parity of reasoning, at least half of the spore god's life is metaphysically impossible. Half of a metaphysically impossible life is no life at all. Lacking an extension of infinite personal time in both directions, Sorensen's thought experiment fails to support his desired conclusion.

Even setting aside Nowacki's metaphysical concerns,⁵ Sorensen's (2005) 'Zeno' spore god faces a dilemma. Horn #1: if 'intermissions' disrupt Pt , traveller-identity fails, so the putative spore god is not one being at all but an infinite string of infinitely-many causally-disjoint beings whose Xt -to- Pt ratio gets ever-bigger the further away from now their history is traced. Horn #2: if only consciousness ceases during 'intermissions' but other traveller-processes (e.g. digestion, cellular division, etc.) continue, the putative spore god is merely an 'ordinary' immortal, (i.e. a non-time-traveller with $Pt = Xt = \infty$). However, just as relativity maps Lewisian TT without any ontologically-privileged 'time itself', general relativity (GR) models Sorensen spore gods without Zeno intermissions.

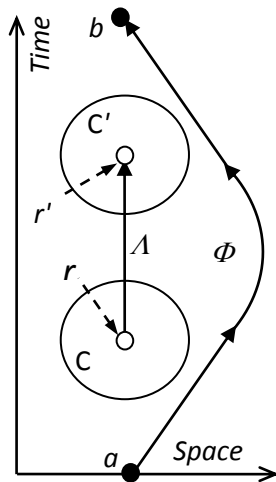
In special relativity's flat spacetime, compressing one frame's infinite duration into another's finite duration requires fatally unbounded accelerations, i.e. no spore gods: $Xt < \infty$ iff $Pt < \infty$. However, GR allows arbitrarily-curved Malament-Hogarth (M-H) spacetimes, (after David Malament and Mark Hogarth). Informally, M-H spacetimes let observers survey infinite- τ worldlines in finite τ .⁶ Below, a spacetime with 'toy'

⁵This discussion aims primarily to defend the coherence of Sorensen's spore gods within a particular family of (general) relativistic spacetimes. Another discussion, about Sorensen's pseudo- and veiled immortals, will try to address Nowacki's (2006) concerns. Gilmore (2016) offers a comprehensive metaphysics for Sorensen immortals but does not treat them in relativistic or (*a fortiori*) M-H terms. Gilmore also, like Sorensen (2005) and Nowacki (2006), uses Lewis's (1976) ontology: e.g. Xt is 'time itself' and Pt is 'not real time' (2016: 1 and 17).

⁶Formally, a spacetime manifold (M) is M-H if it contains 'A future-directed timelike half-curve $\gamma \subset M$ and a point $p \in M$ such that $\int_{\gamma} d\tau = \infty$ and $\gamma \subset I^{-}(p)$ ', (Manchak 2010: 276), where " I^{-} " = causal past.

M-H regions C and C' , (after Hogarth 1994: 127, Fig. 1).⁷ Scalar field values, which determine τ , equal 1 outside C and C' but blow-up arbitrarily at finite distances inside them. Points r and r' are removed so field-values are nowhere *actually* infinite. (No worldline contains r or r' .) C and C' are finite externally but infinite internally: each interior ‘appears quite small [but] is in fact as large as the complement of C' ’, (Hogarth 1994: 126). M-H regions can have any finite external size.

Region C , region C' and their exterior spacetime differ metrically but comprise one causally-unified manifold, e.g. C frame-independently (absolutely) precedes C' .



Worldlines A and Φ are continuous (e.g. no ‘Eleatic’ intermissions), timelike and have finite acceleration. Φ leaves a , avoids both M-H regions and reaches b . A leaves C and enters C' . For Φ , $(\tau < \infty)$ and $(\tau \rightarrow \infty)$ for A yet Φ circumnavigates A . A frame-independently precedes b : any A -point can signal to b but b cannot signal to A . If Pt tracks Φ and Xt tracks A , Φ is *de facto* a spore god, $(Pt < \infty, Xt = \infty)$.

While Φ contrives to be alive throughout all of (infinite) external time, Φ still suffers death after finite personal time, i.e. ceases at point b after a journey of finite duration from a . Also, Φ (*a fortiori*) undergoes FTT, $(Pt \neq Xt; Xt > 0)$. Granted, in this unusual scenario, a and b are (respectively) absolutely earlier and later than any Xt point, but this is a mere artefact of the example in the illustration and not a *general* M-H feature. An alternative ‘spore god’ arena that avoids this problem is Gödel’s (1949) infinite ‘rotating’ BTT-supporting GR universe, wherein every point is M-H and two inertial observers on separate $(\tau = \infty)$ timelike worldlines can have orthogonal time

⁷For variously more sophisticated (and realistic) M-H scenarios, see Hogarth (1994), Manchak (2010), Wüthrich (2015) or Manchak and Roberts (2016).

axes. Again, context settles Pt / Xt choices. If (e.g.) practically the whole physical universe (bar Φ) follows a Λ -like mean path then ($\Lambda = Xt$), while ($\Phi = Xt$) if practically everything (bar Λ) follows a Φ -like mean path.

While Λ has (absolutely) unbounded τ , it does not have infinite *duration* in all frames. Likewise, while Φ has (absolutely) finite τ , it yet encompasses (and surveys) all of Λ 's infinite length. But there is no paradox here: M-H cases may be an extremity of Pt / Xt divergence in duration (one finite and the other infinite), but present no logical difficulty on that account and can still share direction, ($Pt > 0$ and $Xt > 0$). Explaining whence Λ *ultimately* comes (or what states it approaches at infinite limits) seems extremely difficult, but no more so than explaining ultimate states of any infinitely-descending causal chains (temporally infinite or not), (cf. Meyer 2012).⁸ That Λ 's state at infinite limits is unpredictable (or undetermined) is not contradictory.

Lewis (1976: 149) suggests all causal chains, regardless of topology, (finite linear, infinite linear or finite non-linear), face an identical explanatory problem. Where, ultimately, does any worldline come from? To what, ultimately, does any object owe its properties, information content and casual efficacy? Lewis says (*ibid.*) 'There is simply no answer'. One might reject Lewis's 'no answer' view yet accept his *tu quoque* about ultimate causal explanation, e.g. think causal chains may be ultimately explicable but that such ultimate explanations may equally fit any causal chain. Imagine (for argument's sake) a neo-Kantian who believes a) that noumenal selves can 'choose' (atemporally) empirical actualisation of whole causal chains, whether finite-linear, infinite-linear or finite-looped, or b) that 'Uncertain as it may be of the

⁸Quantum mechanics may admit infinite causal descent too – see Norton (1999) or Bokulich (2003).

real possibility of noumenal causality [generating loops], theoretical reason seems justified in affirming the *logical* possibility of the concept', (Adams 1997: 821).

If scepticism about spore gods must invoke physical considerations, this seemingly concedes that their metaphysical incoherence has *not* been established. M-H outcomes seem highly counterfactual but appear nomologically accessible within GR. Indeed, while M-H outcomes seem hard to realise physically (cf. Manchak and Roberts 2016: 2.3), no comprehensive M-H “no-go” theorem yet exists. (Since M-H outcomes involve TT, note Manchak 2011 offers a “No no-go” argument *vis-à-vis* TT.) After surveying possible physical obstacles to M-H outcomes, Manchak (2010: 287) concludes ‘it is not yet clear that such potential problems will turn out to prohibit the physical implementability of supertasks’. (Manchak 2010 suggests seven physical conditions M-H spacetimes should meet and offers a model that satisfies all seven.) An achieved theory of quantum gravity may yet banish any physically realistic M-H but ‘let us proceed for now with the best available (classical) spacetime theory - GR’, (Wüthrich 2015: 1990). One could read M-H outcomes as a *reductio* of GR, but given GR’s successes, this heroic course seems unconvincing.

Sorensen’s spore gods seem metaphysically consistent, nomologically accessible within GR and have yet to be proven physically unrealisable. M-H worlds provide a consistent framework wherein the life of an observer with finite personal time can yet be distributed across all of the infinite external past and future. Hence, as Sorensen argues, being able to view all of (external) time need not prove you against mortality, even if that external time is infinite. Even if spore gods do prove physically unrealisable in our world, they are sufficiently metaphysically and physically robust that Sorensen’s main claims stand: possible lives can extend across infinite (e.g.

external) past and future time but still suffer mortal-like finitude of personal experience and thus deathlike harm.⁹

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